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THE COLUMBIA RIVER BASIN PROJECT FOR WATER SUPPLY AND WATER QUALITY MANAGEMENT: STATUS, POTENTIAL AND NEEDS

Public Health Service
Portland, Oregon

December 1962

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The Columbia River Basin

Project for Water Supply

and Water Quality Management

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Research — A phase of Water Quality Management

The Columbia River Basin
Project for Water Supply
and Water Quality Management

U.S. DEPARTMENT OF HEALTH,
EDUCATION AND WELFARE

Public Health Service
Region IX
Portland, Oregon

December, 1962

RESEARCH REPORT

STATUS, POTENTIAL AND NEEDS

FOREWORD

Within the next two years, the United States Public Health Service will open a new water quality laboratory on the campus of Oregon State University at Corvallis. This will be one of the first regional laboratories to be built under the amendments to the Federal Water Pollution Control Act which were passed by the Congress in 1961.

This "Research Report", more effectively than any other document I have seen, makes clear why this laboratory is so greatly needed and what its responsibilities will be. For a good many years, as this report shows, individual scientists, universities, private research groups and Federal, State and local agencies have been studying various phases of water pollution and water quality in the Pacific Northwest. For the first time, these individuals and institutions will now have a new facility devoted entirely to these problems, which they will be able to use in their own research and training activities.

The Corvallis laboratory will benefit the Northwest in other ways as well. The Federal Water Pollution Control Act calls for a wide range of activities carried on in cooperation with State and local governments and the new facility will be of great help in increasing the effectiveness of of these programs.

Water in the Northwest is uniquely important as a natural resource, as a recreational asset, and as a promise of future economic growth. The scientific community in the region has already contributed much to our understanding of what must be done to protect this resource. It is hoped that new research facilities will help a new generation of scientists continue and build on these past accomplishments.

Gordon E. McCallum

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Assistant Surgeon General
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INTRODUCTION

PURPOSE AND SCOPE OF RESEARCH REPORT

The Public Health Service, Department of Health, Education and Welfare is presently engaged in the collection of essential data on which to develope, with the cooperation of state and other Federal agencies in the Northwest, a comprehensive water supply and water quality management plan for the Columbia River basin and adjacent coastal areas. This project was explained in detail in an "Introductory Report" prepared by the Portland office in March, 1961.

This Introductory Report describes the project as having four major sections or phases, as follows:

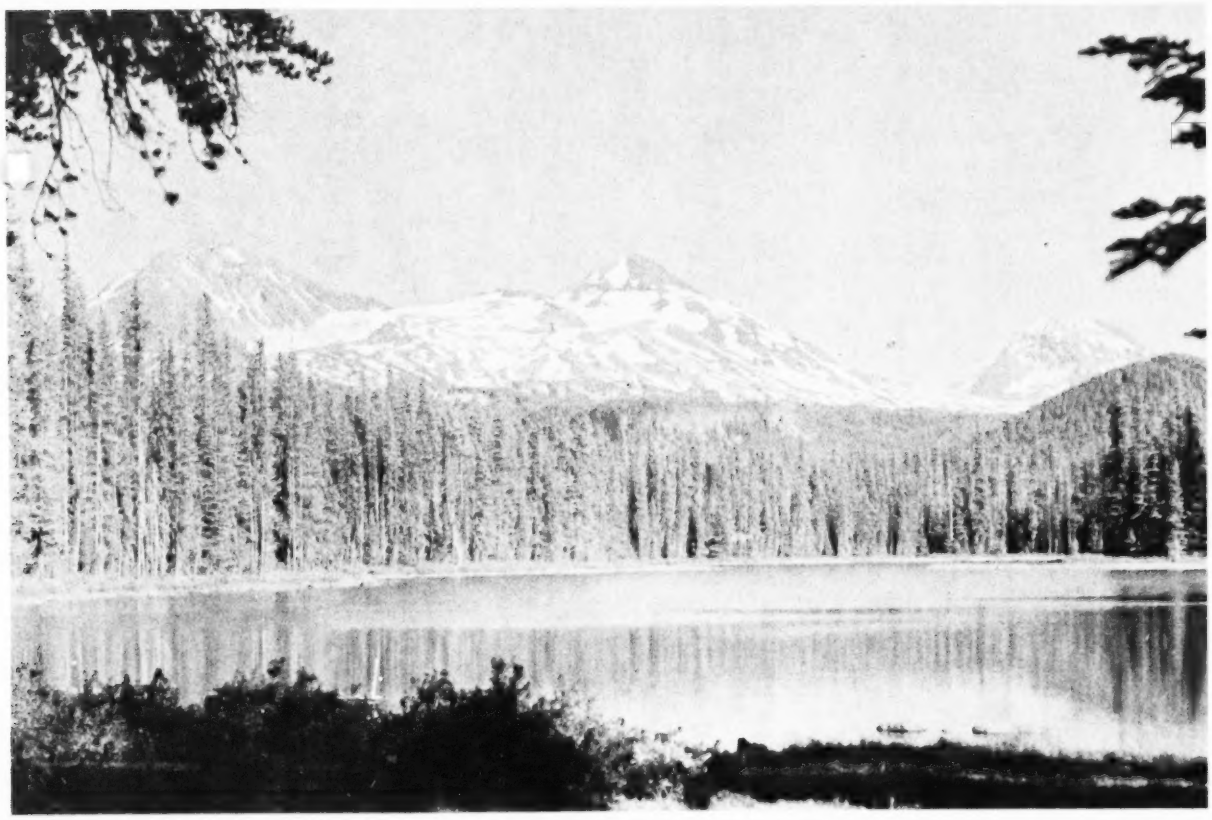
1. "The determination of the water requirements for municipalities and industries in the Columbia Basin region and the development of engineering recommendations to meet these quality requirements."

2. "The development of a water management plan to protect and control the quality of the region's water resources."

3. "The development of a report on the adequacy of water resources to meet the needs of the major using groups, making available information on the volume and the physical, chemical and biological quality of the region's water resources."

4. "The identification of research needs, with particular emphasis on the problems unique to the Pacific Northwest region, and the recommendation of measures for implementing such research at appropriate public and private facilities."

This research report discusses the progress made to date on the fourth phase. Its purpose is to delineate the status and critical needs of water pollution research in the Project area and the capacity of this area to meet the research needs of the future.



Water, timber and mountain combine to give charm to the Northwest.

REGIONAL NATURE OF WATER PROBLEMS

Climate, topography, and patterns of land and water use and industrial development combine to give the Pacific Northwest its special regional characteristics. It is a region of many types of water--the ocean, salt-water estuaries, large river systems, lakes, artificial reservoirs, and natural subsurface reservoirs. Each of these has important uses--uses important to the health and welfare of the Northwest and the Nation.

This is the last major stronghold of the salmon and an important segment of the economy, especially of the western portion of the area, depends upon a fully-producing fishery and shellfishery. Recreation is a major water use. Vast areas are utilized for the production and harvesting of timber. Wood pulping is a major industry. Large areas of Idaho and eastern Washington and Oregon depend largely on irrigated agriculture for their economy. Low electric-power rates have attracted substantial aluminum producing industries. Oil refining is becoming a significant operation in some areas. Mining predominates in portions of Idaho and eastern Washington and food industries are located throughout the agricultural areas.

These factors, developed in more detail in the Introductory Report, result in water problems, many of which are peculiar to the Northwest and often are limited to specific areas of this region. Knowledge regarding these problems is often scanty or completely lacking and can only be provided by a major research effort directed specifically toward their solution.

POLICIES AND CONCEPTS

The Public Health Service has consistently recognized that research is one of its major functions; that the Service's facilities can not encompass all of the needs; that the research potential of the Nation is great; and that a major effort of its programs must be to stimulate and support research at public and private institutions as a means of expanding the research base. Much of the research conducted by the Service's Division of Water Supply and Pollution Control is centered at the Robert A. Taft Sanitary Engineering Center at Cincinnati, Ohio. Plans are under way for a greatly expanded intramural program through the installation of regional laboratories. The Service also supports a very substantial extramural research program by means of a system of grants. This program, too, is increasing. All of this effort is in keeping with the above-stated policy.

As the field of water pollution has expanded and the need for knowledge has grown, more and more researchers and disciplines have been attracted to the field of study. Hence, there is developing in the Northwest an ever-increasing number of entities engaged in research in this field. Many of the projects of these entities have been undertaken as a result of stimulation and support by the Service.

Concepts along with policy have had their influence on research. Concepts regarding water quality control are changing to meet the impact of new situations and to encompass areas not previously considered as significantly affecting the water resource.

For instance, for years the chief concern of the relatively few people engaged in the control of pollution was that of bacterial contamination and the effects of domestic sewage and certain industrial wastes on the oxygen content of water. While these are still important, the approach to pollution control is now much broader and includes consideration of temperature, nutrient concentration, salinity, siltation, turbidity, color, odor, toxicity, and in certain places, radioactivity.

These broader concepts have had their influence on research as evidenced by the type of projects which have been undertaken during recent years. The constantly widening field has attracted many new disciplines in engineering, economics, chemistry, biology and land and water management.

Research is necessary to provide knowledge where knowledge is presently lacking. It is especially essential to comprehensive planning for water quality control and, therefore, a major item of the Columbia River Basin Project for Water Supply and Water Quality Management.

Recreation requires clean water.

FIELDS OF RESEARCH

Although pollution by sewage and industrial wastes remain of primary concern in nearly every part of the United States, the full protection of the Nation's water resources demands the consideration of all factors which affect water quality. Research in this field, therefore, must be designed in its over-all aspects to answer the following questions:

What quality of water must be maintained for the full protection of the water resource and for each of its multiple uses?

What materials or substances affect the quality of the resource and what are their sources?

In what way do these materials or substances affect the quality of water?

How does the altered quality affect each of the water uses?

How can these effects be prevented or controlled?

What benefits are derived?

Water pollution problems of the Columbia Basin Project area are many and varied. Many of them differ significantly from other parts of the country. This section of this research report will briefly describe these major problems and the research required for their solution.

WATER QUALITY

Of primary importance to water quality control is a knowledge of the basic natural quality of water from an unoccupied and undisturbed area. While it certainly is not possible or practical to maintain water in its natural condition throughout its travel to the ocean, a knowledge of what constitutes a natural condition is necessary as a starting point on which to base judgment regarding changes which may occur. For instance, it is important to know what is a normal sediment load under natural conditions, what is the nature of dissolved organics and the bacterial concentration from unoccupied watersheds, how these factors vary with the seasons, and what are the sources or causes of the changes in quality which occur naturally.

The above is related to the next item - that of determining the aquatic environment necessary for the full production of a desirable type of fishery or shellfishery. This may or may not be the environment which occurs naturally. Pollution usually alters the aquatic environment and it is desirable to be able to detect the beginning of an undesirable change, hence the optimum must be known. If the fishery is to be protected and full production achieved, it is necessary that damage be avoided rather than corrected after it occurs.

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Two of the factors which may affect the aquatic environment are toxicity and siltation. Knowledge regarding these two factors is limited and inadequate.

Toxicity may be of two types, acute and chronic. Acute toxicity results in and is detected by an almost immediate kill of aquatic animals. Chronic toxicity is more subtle and results from long exposure to the toxin. This type is not usually detected until after significant and perhaps irreparable damage is done. In some instances, the condition in itself may not be unfavorable for fish and shellfish, but may trigger other biological or chemical activity which will produce water quality conditions which are unsatisfactory for these animals.

Considerable research has been conducted regarding the acute toxicity of many substances to aquatic animals. Methods have been devised to measure the tolerance of the animals to these substances, but tolerance has been largely based on survival. While it is important that the fish or shellfish survive, it is of equal importance that the conditions necessary for a full fishery production be known. This involves the effects on the entire food chain and on the condition of the animal when exposed to the toxic material. Therefore, it is essential that methods be devised to detect trends toward chronic effects of toxicity under varying conditions.

Siltation is a different but commonly occurring problem. It is augmented by the increases in land clearing and use. One of the principal effects occurs in the areas of streams used for fish spawning. Here again, methods to measure and assess the effects of and detect trends toward damage to the environment are of primary importance.

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Road construction adds to sediment load of a stream.

Another factor which may affect water quality is the impoundment of water for power, water supply, irrigation, or other uses. The demands for more and more water in many cases can only be met by holding back water during periods when it is plentiful, for use when it is short and when the demands are high. At the rate reservoirs are being constructed on main stems of rivers, as well as on tributaries, many of these streams will eventually consist of a series of artificial pools.

One of the objectives of augmenting the flow of streams is for quality control since, even with the best known methods of sewage and waste treatment, there may be a need for effluent dilution. The 87th Congress recognized this need by the passage of Public Law 87-88 which provides for including storage for water quality control in reservoirs constructed by Federal agencies.

While the additional flow will improve the quality by dilution below the reservoir, the alteration of the stream and the ponding of water may change its quality as well as the ecology of the system. Some of the quality factors which may be altered are temperature, oxygen concentration, siltation, and nutrients. The capacity of the stream to support the desired fish life and even its ability for self-purification may be affected. These effects may not all be detrimental, but they must be known.

The states of Oregon and Washington are bordered on the west by the Pacific Ocean and these coastlines are indented with marine estuaries, both large and small. Much of the population and industrial development of these states is located in these areas. The quality of these marine waters has not been given adequate consideration. They are important habitats for a large shellfish population, as pathways for migrating salmon, steelhead trout and other marine species of fish, as recreation areas for large numbers of people both from within and outside the region, and for transportation.

Marine estuaries and the ocean are the final repository for the wastes from the land whether they are discharged direct or by way of the fresh water streams. Contrary to what seems to be common opinion, these receiving waters do not have an unlimited capacity to handle wastes without damage to the quality of the water. Tidal movements differ materially from the directional flow of streams. Wastes may tend to accumulate in estuaries and in near-shore ocean waters. Thus, current direction and velocity, diffusion rates, the effects of waves, the up-welling of low-oxygen water, the ecology of marine waters, etc., are areas of study which have not been adequately investigated.

Puget Sound in the State of Washington is one of the largest estuaries in the country. Many sizeable streams flow into it, large cities and industries contribute waste material to the waters, it has an important marine fishery, tide flat areas are used for oyster production and certain areas produce many other types of shellfish, ships from all over the world use its ports, and recreation is a major activity. Pollution control activities in this important estuary will be greatly enhanced by research regarding its present or potential quality problems. A major research effort is essential.

Another major marine study is required along the coasts of the region. For instance, the rapidity with which timber grows on the western slopes of the Coastal Range makes necessary the further expansion of the pulp and paper industry in these areas. Coastal streams are much too small to act as receiving waters for the wastes from mills, even after the best known methods of recovery and treatment are applied. The same is true of many of the estuaries. Therefore, the location of these mills and their methods and points of waste disposal, which undoubtedly will have to be the ocean, are dependent upon the results of research.

SOURCES OF POLLUTION

Wastes and Effluents

In very few instances is raw sewage from communities of the Northwest discharged without treatment into natural waters. Methods of treatment, however, vary widely both as to type and efficiency and in no case are constituents completely removed. Sewage effluents are, therefore, a source of pollution even after the highest known degree of treatment has been applied. Interest is developing regarding the composition of these effluents and the components which escape even the best treatment, detergents for instance. There is a need for a more intensified study of effluents. Included in this study should be the detection and identification of organic substances, toxins, and trace elements.

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Much is said about the pollution resulting from the discharge of wastes from industry, but little is known concerning the composition of many of these wastes. Information is especially lacking regarding these constituents which are present in small amounts, but which may be of more significance than the material which predominates. For instance, many industries use chemicals for the control of molds and fungae in equipment and on products. Many others use special compounds in clean-up operations. In very few cases are these materials identified and evaluated in terms of their effects on the receiving waters. This may not be strictly a research project, but it represents a study to supply badly needed information.

Land Use

Many land use activities contribute silt to natural water courses. The principal source of silt is erosion of forest, agricultural, and grazing lands. In certain locations operations such as mining, gravel washing and highway construction contribute heavily to the silt load. Erosion can no longer be considered merely a natural phenomena. Man's activities are said to contribute more to erosion than all natural causes combined. While this may be subject to question, it is certain that with knowledge of the factors governing desirable land use, erosion and silt production can be largely controlled. Since erosion is a product of soil characteristics, climate, runoff, topography, and vegetative cover, their respective influences must be investigated.

Numerous investigations have been made of erosion and sediment load problems in the United States, but much of the available information deals with areas

Irrigation is a source of pollution.

whose soils and climates differ markedly from those of the Columbia Basin area. Moreover, most of this work has been focused on land use rather than water quality or the condition of the receiving stream.

The economic benefits from better control are great. Siltation and turbidity not only reduce the quality of domestic and industrial water supply, but increase the cost of water treatment. There is evidence that a significant part of the decline in fish runs is due to the effect of sediment on the aquatic environment. Even the ability of a stream to assimilate and recover from the effects of sewage and waste effluents may be substantially reduced by an excessive silt load.

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When water is used for the irrigation of land, a portion of this water is returned to surface streams or groundwaters. This return water is called "irrigation return flow" and is known to be a source of materials which affect the quality of the receiving water. Over 5,000,000 acres of arid land is under irrigation in the Columbia Basin and this area will be increased almost 50 percent by 1970.

The average quantity of water used daily for irrigation in this region is about 45,000 million gallons of which (it is estimated) one-third or 15,000 million gallons is "return flow." While complete knowledge is not available regarding the significance of this source of pollution in all areas, it is known that return flows cause an increase in mineral matter, nutrients, temperature, odors and tastes and turbidity in many receiving streams. It is suspected that toxic insecticides and herbicides applied to land and crops may be contributed to streams and this also is a factor which requires study.

Two studies of irrigation returnwaters are underway in the state of Washington. One by the Engineering Department, University of Washington, deals with the problems in the Yakima River Basin. Washington State College, Engineering Department, is conducting the other study in the Columbia Basin Irrigation Project area. These projects will undoubtedly enhance the knowledge regarding this source of pollution.

WASTE UTILIZATION AND TREATMENT

The fundamental processes of sewage treatment in use today have not changed materially in the last forty years. Improvements have been made in structures, equipment and operation procedures, but substantially the same limitations that were inherent in the processes remain. Increasing population and industrialization within metropolitan areas and the presence of new substances (such as detergents) in the wastes from these areas combine to make the development of new and more effective treatment methods imperative.

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In the past the development of methods for the recovery, utilization and treatment of wastes from industrial processes has been largely left to the industry. While this is still a responsibility of industry, because the public is affected by these wastes in the natural waters, government also has responsibility to do research in this field.

Among the industrial wastes of this area on which further research is needed are those from pulp and paper, potato processing, chemical, the newly developing petrochemical industry, and mining.

SOCIAL AND ECONOMIC

The social and economic aspects of water pollution are as important to the water resource management program as are the more technical scientific aspects. A further understanding is needed: of the relationships of water quality to the social needs and welfare of individuals, communities and the region; the social tolerances to water quality and its control; and the measurement of public awareness. Devices must be developed for creating public understanding and support. The social aspects represent an almost untouched field of study and should attract new disciplines to the research field.

Water resource planning, both for quantity and quality, is dependent upon economic analyses and adequate forecasting of population and industrial growth. Forecasts of community and industrial growth in regions of the Northwest have been made by various governmental agencies, educational institutions, and consultants in past years. Since forecasting is not an exact science, various techniques have been used depending on the forecaster and his objectives.

One method by which these techniques may be evaluated and improved is to compare existing forecasts with the actual development which occurred since they were made. If there are significant differences, there may be evidence of factors which were either not recognized or were considered unimportant by the forecaster. This is a form of research which may be applied to the techniques used in economic phases of water resource planning.

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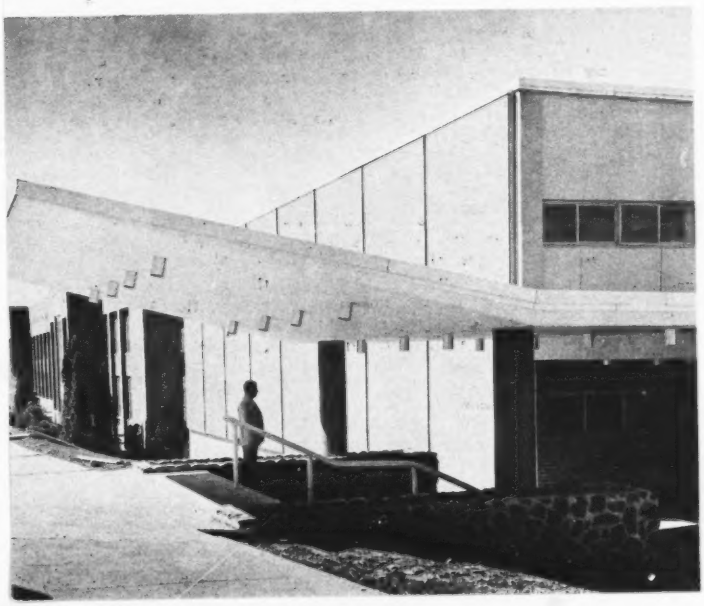
The above discussion indicates the scope of the research requirements of this region and points to the urgent need for a greatly expanded research effort. The section which follows will describe the available and planned resources for research in the Pacific Northwest. Whether or not these resources will be adequate to fulfill the research needs will depend upon how well they are utilized and supported.

RESOURCES FOR RESEARCH IN THE NORTHWEST

Resources - facilities, equipment and personnel - for research on water pollution and related problems have increased substantially in the Pacific Northwest in recent years. The Public Health Service in Portland has compiled for each of the past three years inventories of research projects underway in this area which indicate the rapid development of interest in this field of study. These inventories show that 63 projects were underway in 1959 in Oregon and Washington. This number increased to 77 in 1960 and to 105 in 1961. The 1961 inventory lists 136 projects for the entire Northwest - states of Alaska, Idaho, Montana, Oregon and Washington and western British Columbia. The increase in the number of projects has been accompanied by a more or less proportionate increase in research resources. Consequently, there is developing in this region a considerable capacity to do research in this field. The following pages briefly describe these resources, their potential, the subjects under study and some of the plans for the future. Titles of the projects underway in the Columbia Basin project area are listed in the Appendix.

EDUCATIONAL INSTITUTIONS

Next to training, research is a major function of most universities and colleges; consequently, much of the resource for research in this region exists in the institutions of higher learning. In addition to the accumulation of facts and knowledge, these schools use research in the training program of postgraduate students. The following institutions have substantial research programs underway in this field: Oregon State University at Corvallis, Washington State University at Pullman, the University of Washington at Seattle, Portland State College at Portland, and the University of Idaho at Moscow. Other institutions with potential in this field, but presently with limited programs in the field, are: the University of Alaska at Fairbanks, the University of Oregon at Eugene, Montana State College at Bozeman, the University of British Columbia at Vancouver, Reed College at Portland, and Linfield College at McMinnville. (The above list by no means contains all of those universities and colleges having potential for this type of study.)



Research laboratories in new Engineering building, Washington State University.

Oregon State University

Oregon State University is a land grant institution with an undergraduate enrollment of approximately 8,000 students and a graduate school of about 850. The University administration places considerable emphasis on its research program. A number of departments have for years conducted studies in the water resource field. Outstanding in water pollution studies have been the Civil Engineering and the Fish and Game Management Departments. A biological unit of the Robert A. Taft Sanitary Engineering Center has been located on the campus under a cooperative arrangement between the Public Health Service and the University.

Interest in water resource research has developed in a number of other departments of the University in recent years. This increased interest has resulted in the establishment of a Water Resources Research Institute under the administration of the Agricultural and Engineering Experiment Stations. The purpose of this Institute is to "plan, encourage and facilitate research on the factors which affect the quantity and quality of water." More than 44 scientists and numerous graduate students from many disciplines - engineering, agriculture, biological and physical sciences, fish and game, forestry and oceanography - are now engaged in water pollution and related research.

In 1961 the Institute listed 34 projects underway on subjects related to water pollution problems. These projects were supported by funds from various sources in an amount exceeding $345,000 for the year. A list of these projects is contained in the Public Health Service 1961 research inventory previously mentioned and in the Appendix to this report.

The facilities for research at the University include well-equipped scientific laboratories, a natural stream for aquatic environment studies, a watershed to determine the effects of logging on water quality, a shellfish laboratory on Yaquina Bay, ships, boats and gear for oceanographic research, pilot installations for waste treatment investigations, and a statistical and economic analysis unit. These facilities are gradually being supplemented by new equipment.

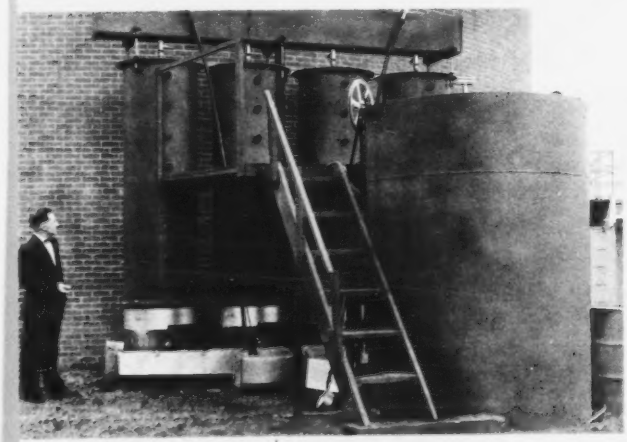
Washington State University

Washington State University is also a land grant institution located in eastern Washington in the heart of the agricultural area of the Northwest. Its undergraduate and postgraduate enrollment is about 7,800 and 600 respectively.

A natural stream controlled for aquatic research.

A unique feature of the University was consummated in 1945 by the establishment of an Institute of Technology. At the same time, and within the Institute, a Division of Industrial Research was founded. All directed technological research of the University is centered in this Division. Its facilities, however, are augmented by other disciplines of the University when special skills are required. The purpose of the Division is to "serve industry and render technical assistance to government."

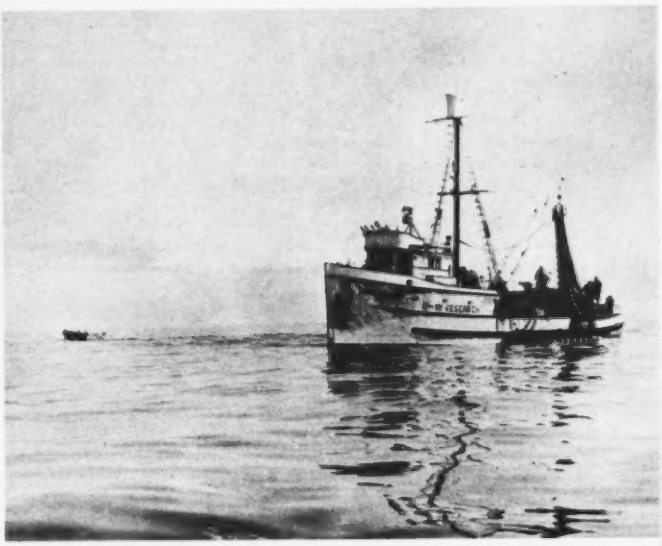
Two programs of the Division conduct research on subjects related to water pollution, namely, sanitary engineering and hydraulics. The sanitary engineering research program is presently housed in a new Engineering Building for which the Public Health Service made a research construction grant of approximately $50,000.



Sewage Treatment research at Oregon State University.

The 1961 inventory lists ten projects underway supported by funds in the amount of approximately $99,000. Most of the projects are related to problems of the arid agricultural area. The major subjects of study are irrigation return flow, slimes in irrigation water, organic pesticides, the treatment of food industry wastes, and sewage lagoons.

The Sanitary Engineering research staff consists of nine full- or part-time scientists supplemented by members of the Departments of Bacteriology and Soils and a number of postgraduate students. The facilities for research consist largely of laboratories both at the University and in the field. Two pilot installations are available at the Pullman sewage treatment plant, a biological filter and a series of sewage lagoons.



University of Washington ship for oceanographic research.

The hydraulic unit of the Division has developed considerable competence in hydraulic model construction. This unit recently constructed a model of the Umpqua estuary under a contract with the Public Health Service, Portland, and it is to be used in connection with field studies of factors influencing the disposal of wastes in marine estuaries.

University of Washington

Research in fields related to water pollution at the University of Washington is largely centered in four schools - engineering (sanitary and hydraulics), oceanography, fisheries, and chemistry - with limited studies in three others - zoology, forestry, and health sciences. Coordination is accomplished through the office of the Dean of the Graduate School.

Loading for Research in marine waters.

Because of the varied interests of these schools, the types of projects differ widely. The 1961 inventory lists 22 studies underway. Information available on 16 of these projects indicates financial support exceeded $292,000 for the year.

The Sanitary Engineering Division of the University has been active in this field of research for upwards of 40 years. Projects have dealt largely with sewage or waste treatment processes and investigations of water quality in various parts of Washington. In this latter field, the division has built up considerable competence and equipment.

The Oceanographic Department has excellent field and laboratory equipment which has been used in water pollution studies in Puget Sound. Working models of the Sound are available as tools to be used in connection with field studies.

A number of years ago, in order to coordinate research in the field of fisheries, a Fisheries Research Institute was established. This Institute employs its full-time staff as well as supporting the work of faculty members and graduate students of the School of Fisheries. A limited number of projects related to water pollution have been undertaken and facilities are available for a greatly increased program on this subject.

The Department of Chemistry has for a long period been the focal point in the University for pulp mill waste research. These studies have been supported by the industry and coordinated by a Pulp Mill Technical Committee. Investigations have been largely applied to waste utilization. The Department of Zoology has made extensive studies of algae in Lake Washington.

This University has considerable potential in personnel and facilities for a much expanded program of research in the water pollution field.

Portland State College

Portland State College is a rapidly growing state educational institution. Until recently research has been a matter of individual effort and there were no projects on subjects related to water pollution. Somewhat over a year ago a committee of staff members evaluated the interest within the science departments for doing research in the environmental health and water resource fields. The Committee's report was so favorable that the College administration applied for and obtained approval of a National Institute of Health construction grant to add a floor to a proposed Science Building in which this type of research will be conducted. This building is scheduled for completion in 1964. In the meantime, three projects were initiated, supported by Public Health Service grants in the amount of $45,000 annually. This College has considerable interest, but, presently, limited facilities to do research in this field.

University of Oregon

The University of Oregon at Eugene does not presently have a study program which can be identified as water pollution research, although some of the oceanographic and estuarine studies in the Coos Bay marine station are related to this field. This section has a potential and facility for this type of investigation.

University of Idaho

Idaho University at Moscow, Chemical Engineering Department, is conducting research on potato processing wastes with funds from the State of Idaho. The University has limited facilities for industrial waste studies. Funds for 1961 projects amounted to $10,800.

Summary

The above description of research in the water pollution and related fields conducted by universities and colleges of the Northwest indicates that a considerable capacity for this type of study exists in these institutions. The total funds for projects underway at these universities and colleges in 1961 exceeded $791,800. While this represents a substantial research effort, it by no means utilizes the total potential of the educational institutions in this area. Neither does it meet the research needs of the region.

INDUSTRY

Industrial research in the field of water pollution and waste disposal in the Northwest is largely limited to that of the pulp and paper industry. Since a considerable portion of the wood used for the manufacture of pulp is wasted, research is largely directed toward the recovery or utilization of this material. Each company of the industry has developed substantial facilities for by-product development. This type of study is important to the continued existence of this industry and more complete utilization of the Nation's resources.

Other investigations related to the water pollution problems of the industry include: those of the Northwest Pulp and Paper Association on conditions in areas receiving pulp mill wastes; the Crown Zellerbach facilities at Camas for the study of the slime problem of the Lower Columbia River; the biological laboratory of Rayonier, Inc., at Hoodsport where extensive studies are underway on the pulp waste-shellfish problem; and the National Council for Stream Improvement unit at Oregon State University for studies of waste treatment processes and the slime problem.

STATE GOVERNMENT

Research has not been a major function of state water-pollution regulatory agencies although they have the primary responsibility for applying the knowledge gained. The investigations made by these agencies are more of the field survey or demonstration type.

However, both the Washington Pollution Control Commission and the Oregon Sanitary Authority have conducted limited research in the biological field and have at times financially supported studies by other organizations. Laboratories and personnel of these agencies are not well adapted for research purposes. Because of their need for information as a basis for water pollution control activities, it appears desirable that these agencies either increase their own facilities for research or request funds for the support of this type of study in other organizations of the several states.

The Washington Fisheries Department has a well-equipped shellfish laboratory at Quilcene where studies of the effects of pulp mill wastes on oysters are presently underway. These studies are supported by a direct appropriation of the State Legislature to aid in the solution of the pulp-mill oyster problem. In addition to aquaria, a salt water inlet has been developed for these studies.

The Oregon Game Commission has a small research division working on the effects of logging practices on fish production. The facilities of this division are partially combined with those of the Fish and Game Management Department, Oregon State University and the Alsea watershed project mentioned below.

The Oregon Fish Commission utilizes some of its field facilities for studies relating to water pollution as it affects fish on the Oregon coast and lower Columbia River.

The Oregon Water Resources Board, in cooperation with other agencies and industries, have developed extensive facilities for watershed studies in the Alsea Basin. Headquarters for the study are located at Oregon State University. These facilities have been developed for a long-term study of the effects of logging and other land practices on water quality and fish production. They consist of gaging stations, weather stations, fish traps, equipment for aquatic productivity measurements, etc.

FEDERAL GOVERNMENT

Research is a function of many Federal agencies, especially those involved in the water resource field. The emphasis given to research, however, varies depending upon the responsibilities of the agency. Only a few have responsibilities involving the quality of the water resource.

U. S. Public Health Service

The Division of Water Supply and Pollution Control of the Public Health Service has a major responsibility for conducting research in this field. At present, intermural research in the Pacific Northwest is limited to four units of the Service, namely: The biological unit previously described, located at Oregon State University, and using facilities developed jointly with the Fish and Game Management Department; a shellfish sanitation laboratory located at Purdy, Washington, to study the sanitary aspects of shellfish production and marketing; the Arctic Health Research Center at Anchorage, Alaska, where presently three projects related to water pollution are underway with a 1961 appropriation of about $50,000; and the Portland office from which this report originates.

The latter is equipped largely for the field-survey type of study. Its facilities consist of boats and gear for physical, chemical and biological studies in both fresh and marine waters, a fair-sized and well-equipped laboratory, and a working model of the Umpqua estuary. Personnel are available for engineering, scientific, economic and land management investigations.

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In May of 1957 the Division of Water Supply and Pollution Control of the Public Health Service established an activity in the Portland office, known as the "Research and Technical Consultation Project." This was an effort to provide a device by which to bring the Service closer to the extramural research activity. The major objectives of the project are to stimulate interest in research in this field, to attract new disciplines, to identify the needs and explore in depth new areas of research, to catalogue the studies underway to prevent duplication, and to otherwise provide a technical service to researchers and regulatory agencies in the water pollution and water resource fields.

Under this project continuing contacts have been made with research entities, a series of ten symposiums has been held on various subjects, yearly inventories of research projects have been prepared, and numerous required studies have been delineated in depth.

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The intramural research of the Public Health Service and the Service's ability to support extramural research in this area will be greatly enhanced by the establishment of a regional laboratory recently authorized by the 87th Congress. Section 2e of Public Law 87-88, HR 6441, requires that the Secretary of the Department of Health, Education, and Welfare "establish, equip and maintain field laboratory and research facilities" in var-

Working model of Umpqua estuary.

ious areas of the United States, one of which is the Pacific Northwest. These laboratories are to "conduct research, investigations, experiments, field demonstrations and studies and training relating to the prevention and control of water pollution." The law further states that these facilities "shall be located near institutions of high learning" as an aid to graduate training.

This $2,000,000 water quality laboratory for the Pacific Northwest will be located on the campus of Oregon State University at Corvallis. The appropriation has been made by Congress and construction and staffing plans are underway. It is anticipated that the laboratory will be ready for use by mid-1964.

The objective of the Federal Water Pollution Control Act is to prevent and control water pollution. Consequently, working within the framework of this responsibility, Public Health Service research must largely be directed at the control and prevention of both immediate and future water quality problems. The approach of the educational institution is that of adding to knowledge and utilizing research as a training tool. This means that although projects may be similar, the approach to research may differ. Therefore, the research activities of the universities and colleges and the Public Health Service complement one another, and therein lies the real value of the regional laboratories.

Other Federal Agencies

The Northwest Branch of the Soil and Water Conservation-Agricultural Research Service, located at Boise, Idaho, is conducting extensive studies of precipitation, snow-melt, evapo-transpiration, soil geology and vegetation on sediment movement and runoff.

The U. S. Geological Survey and the Forest Service utilize certain of their facilities in studies of factors affecting erosion, sediment loads and turbidity. The Research Division of the Forest Service has installed sediment traps in four small Oregon watersheds.

The Geological Survey has excellent facilities for water quality basic data collection. These facilities are not utilized for the research type of study.

The Atomic Energy Commission and its contractor, General Electric, at Hanford, Washington, are exceptionally well equipped to study the radiological water problem and the effect of atomic energy operations on the surface and ground water resources. The research at Hanford includes the disposal of high- and low-level waters, the uptake of isotopes by aquatic organisms, the effects of the Hanford operations on the quality of Columbia River water and on the groundwaters of the reservation, etc. This Commission contracts with educational institutions of the area for research on special problems. In brief, it can be stated that the facilities at Hanford, together with those of other organizations in this area, are well equipped for radiological research in the water pollution field.

Site of Public Health Service Regional Laboratory, Oregon State University campus.

RESEARCH AIDS AND SUPPORT

Reference was made in previous sections of this report to the Public Health Service grants programs. These grants as they apply to the water supply and pollution control field are of five types:

1. Health research facilities construction grants, intended to assist in providing adequate research buildings and equipment. This grant provides up to 50 percent of the necessary cost of the research facilities for which it is made. A number of educational institutions in the Northwest have received grants of this type.

2. Research grants which support specific projects. These grants are awarded to individuals for the conduct of basic and applied research projects. The purposes of this type of grant are to expand such research activities throughout the country and to encourage investigators to undertake studies in new and neglected areas. The 1961 inventory of research, previously referred to, lists 27 projects supported by this type of grant in educational institutions of the Columbia Basin area. The total of these grants exceeded $373,000 for that year.

3. Project training grants, intended to assist schools of public health and sanitary engineering in expanding and improving curricula and staffs.

4. Research training grants to assist schools of public health and engineering by giving aid to post baccalaureate students possessing or having potential research talents.

5. Research fellowship grants intended to assist individuals at the pre- and post-doctoral level who have demonstrated outstanding research talents in the water pollution field.

The last three grants recognize the need for training researchers in this field. A number of institutions in this area have taken advantage of the training grants programs.

A number of other Federal agencies are authorized to make grants to non-profit organizations and educational institutions for conducting research on subjects related to the water quality field. These are listed and described in a bulletin called, "Federal Agencies Financing Research," which may be secured from the Social Legislation Service, 1346 Connecticut Ave., Washington 6, D.C.

SUMMARY

A major research effort is required in the Columbia River Basin and adjacent coastal areas to provide the knowledge necessary by which to consummate and carry out a comprehensive water supply and water quality management plan. The resources both in facilities and personnel are considerable, but not yet ample to carry out the concentrated effort required. These resources will be significantly increased as a result of the installation of the Public Health Service regional laboratory at Corvallis, Oregon. This laboratory will not only expand the capacity of the Service to do research in this region, but will be the means of increasing the interest and facilities for research over the entire area. Thus, it is hoped that answers to the many water quality problems described herein will be forthcoming in the years ahead.

APPENDIX

TITLES OF RESEARCH PROJECTS UNDERWAY

The titles of research projects underway in the Columbia Basin Project area in 1961 are listed below under various categories. The initials shown following each title are those of the organization where the projects are located.

University of Idaho - UI
University of Montana - UM
Oregon State University - OSU
University of Washington - UW
Washington State University - WSU
Oregon Game Commission - OGC
Oregon Fish Commission - OFC
Washington Pollution Control Commission - WPCC
Washington Department of Fisheries - WDF
U.S. Geological Survey - USGS
General Electric - Hanford -- GE-AEC
National Council for Stream Improvement - NCSI
Crown Zellerbach Corporation - CZ
Idaho Potato Industry - IPI

SEWAGE TREATMENT

Waste Water Lagoon Criteria for Marine Climates - OSU.

A Study of the Operation and Design Criteria of a Waste Stabilization Pond in a Marine Environment - UW.

Aspects of Deep Trickling Filters - OSU.

Development, Design and Study of Waste Treatment Facilities for Handling Closed Cycle Works - UW.

A Study of Factors Controlling Anaerobic Reaction Rates - UW.

Utilization of L-Arginine in Activated Sludge - UW.

A Study on the Environmental Changes Caused by the Discharge of Digested Sludge at Alki Point, Seattle, Washington, UW.

The Effect of Industrial Wastes on Anaerobic Digestion, WSU.

Limnological Study of Anaerobic-Aerobic Sewage Ponds, WSU.

Sewage Disposal by Spray Irrigation.

WATER QUALITY

Character and Significance of Irrigation Return Flows, UW.

Sediment Production of Forested Watersheds, USGS.

The Effect of Logging on Aquatic Resources, OSU.

Effect of Irrigation Use on Quality of Return Waters, WSU.

A Study of Green River Water Quality as Related to the Future Impoundment of the Howard A. Hanson Dam, UW.

The Change in Quality of Ground Water as Influenced by Sugar Refining Operations, WPCC.

Biochemical Behavior of Pesticides in Natural Waters, UW.

The Effect of Slaughterhouse and Feed Lot Operations Upon the Sanitary Quality of the Yakima River and its Major Tributaries, WPCC.

Stream Sediment Investigations - MFG.

FISH AND AQUATIC LIFE

The Effect of Spent Sulfite Liquor on Oysters, WDF.

Effects of Logging on Salmon Streams in Southeastern Alaska, UW.

Observations on Pollution and Other Factors as They Affect the Fishery of the Lower Columbia River, OFC.

The Effects of Logging on Aquatic Resources, OGC.

Dissolved Oxygen Requirements of Fishes, OSU.

Effects of Logging on Productivity of Pink Salmon Streams in Alaska, UW.

A Study of Changing Water Quality Due to Pollution on the Steelhead Fishery of Chamber Creek, Washington, WPCC.

Growth and Survival of the Pacific Oyster in Washington, UW.

Bottom Sediment in Relation to Oyster Growth and Condition, WDF.

Chondrococcus Columnaris as A Disease Organism in Fish, GE-AEC.

Clam and Oyster Larva as Specimens for Bioassay, WDF.

Toxicity of Organic Insecticides to Northwest Fish, OSU.

Sub-Gravel Dissolved Oxygen in Spawning Gravel and the Food Index, Condition Factors of Fish and Population Studies in Rearing Areas, WPCC.

Ecology and Population Dynamics of Razor Clams, WDF.

Epidemiology of Cryptobia, A Hemoflagellate of Salmon, UW.

OCEANOGRAPHY

Oregon Oceanographic Studies, OSU.

Observations on the Ecology of the Ocean Beach in Relation to Paper Mill Effluents, OFC.

Puget Sound Model Studies, UW.

Estuarine Pollution Factors, OSU.

Oceanographic Effects of the Columbia River, UW.

BIOLOGICAL

The Effect of Airplane Wash Water on Stream Biota and A Determination of the Component Responsible for Toxicity, WPCC.

Effect of Pulping Operations Upon the Water Quality and Bottom Fauna and Flora of the Spokane River, WPCC.

Ecological Studies of An Experimental Stream and The Effects of Organic Enrichment, OSU.

Effects of Exchange Rate, Light Intensity and Velocity on Periphyton Development in Artificial Streams, OSU.

Biology of the Madison River, UM.

Primary Production Measurements in a Controlled Flow Stream, OSU.

Studies of the Trophic Dynamics of Simplified Communities in Artificial Streams, OSU.

Effect of Changing Water Quality on the Biota of McNary Pool Before and After Kraft Effluent Discharge, WPCC.

A Water Quality and Ecological Study of Green Lake and its Environment, UW.

Relative Toxicity of Sulfite Waste Liquor, WDF.

Ecology of An Experimental Stream, OSU.

AQUATIC GROWTHS

Factors Affecting the Production of Sphaerotilus Slime in Waters Receiving Pulp Mill Effluents, NCSI.

Evaluation of Humates in the Growth of Plankton Algae, OSU.

The Control of Sphaerotilus in Irrigation Waters, WSU.

Pollution and the Sphaerotilus Problem Including A Study of Sugar Concentrations on Slime Development, WPCC.

Determination of Variables Supporting Sphaerotilus Growing in the Columbia River, CZ.

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INDUSTRIAL WASTES

Scale-Up of a Bernoulli-Type Aeration Device, UI.

Sulphite Waste Treatment, WSU.

Flotation of Colloids from Potato Wastes, UI.

Pulp and Paper Mill Waste Disposal by Irrigation and Land Application, NCSI.

Utilization of Potato Peeling Wastes, UI.

Identification of Toxic Constituents of Kraft Pulp Mill Wastes, OSU.

Treatment and Utilization of Potato Processing Wastes, IPI.

ATOMIC ENERGY

Columbia River Radioecology Studies, GE-AEC.

Health Hazards of Radioactive Wastes in Marine Food Chains, OSU.

Absorption and Metabolism of Radioisotopes by Aquatic Organisms, GE-AEC.

Toxicity of Radioelements to Aquatic Organisms, GE-AEC.

Ground Waste Investigations (Disposal of Radioactive Wastes to the Ground), GE-AEC.

Geological Studies and Soil Physics (As Related to the Ground Disposal of Radioactive Wastes), GE-AEC.

Radiological Evaluation of the Columbia River - Hanford to Vancouver, Washington, GE-AEC.

Environmental Contamination (Resulting from Hanford Disposal Practices), GE-AEC.

Effects of Hanford Process Effluents on Aquatic Organisms, GE-AEC.

Special Studies and Monitoring Methods (Disposal of Reactor Effluent to Surface Waters), GE-AEC

ANALYTICAL

Comparison of Coliform Determination Methods, WSU.

Coulometry: Determination of Dissolved Oxygen, OSU.

Chemistry and Toxicology of Complex Cyanides, OSU.

Studies of the Guppy as A Test Animal for Toxicity Bioassays, OSU.

Analysis of Organic Pesticides by Gas Chromatography, WSU.

MISCELLANEOUS

Hydrology of the Columbia River Basalt, USGS.

Artificial Recharge of Basalt Aquifers at The Dalles, Oregon, USGS.

Short and Long-Range Analysis of Relationship Among Weather, Impoundments, and Diversions Affecting Columbia River Temperatures, GE-AEC.

Ecology of Paralytic Shellfish Toxicity in Washington, UW.

A Study to Determine Required Refinements in Techniques in Order to Reduce the Perimeter of Sanitary Survey Values to Applicable Levels, WPCC.